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EEEL Researchers provide first quantum-based ac voltage calibration to US industry

Researchers in EEEL's Quantum Electrical Metrology Division (QEM) have completed the world's first quantum-based ac voltage calibration and have delivered results with unprecedented accuracy to a major US manufacturer of calibration and test equipment. To make this calibration a thermal transfer standard was measured directly against a quantum ac source using pulse-programmable Josephson junction arrays. This ac Josephson Voltage Standard (ac JVS) is presently being developed into a calibration system by QEM researchers in Gaithersburg, MD, using technology developed by QEM personnel in Boulder, CO.

The customer's thermal transfer standard was calibrated directly against the ac JVS at voltages ranging from 2 mV to 100 mV at frequencies from 2.5 kHz to 20 kHz. Owing to the quantum-based accuracy of the ac JVS, the uncertainties associated with traditional range-to-range scaling techniques for thermal converters are excluded from the uncertainty analysis. For this particular calibration, the ac JVS enabled reductions in uncertainty of more than an order of magnitude at the lowest voltages, and reductions of more than 10 % at 100 mV. The measurement uncertainties at the lowest voltages are by far the smallest ever given for an ac measurement.

Although this calibration demonstrated the unprecedented performance of the ac JVS, it was a special test not generally available to calibration customers. QEM researchers in Gaithersburg are continuing to integrate the ac JVS into the calibration service for thermal transfer standards in order to bring quantum accuracy to the routine calibration service. In Boulder, QEM personnel are developing a next-generation quantum chip with 200 mV maximum output voltage. Achieving 200 mV output voltage will enable the quantum standard to operate at voltages accessible by the QEM's multijunction thermal converter primary standards, already the world's most accurate ac metrology instruments

in the voltage range from 200 mV to 2 V, and enable significant reductions in uncertainty from 2 V all the way down to 2 mV.